Remarks

Claims 1, 2, 4-9, 11-13, 15-19, 21-23, 25-27, 29, 32, 35 and 37-39 are currently pending in the subject application and are presently under consideration. Claims 1, 8, 17 and 18 have been amended as shown on pp. 2-6 of the Reply. Claims 2, 9 and 19 have been canceled.

Favorable reconsideration of the subject patent application is respectfully requested in view of the comments and amendments herein.

I. Rejection of Claims 1, 2, 4-9, 11-13, 15-19, 21-23, 25-27, 29, 32, 35 and 37-39 Under 35 U.S.C. §112, first paragraph

Claims 1, 2, 4-9, 11-13, 15-19, 21-23, 25-27, 29, 32, 35 and 37-39 stand rejected under 35 U.S.C. §112, first paragraph as failing to comply with the written description requirement. The Examiner states that there is no disclosure for "non-coated side of the component, opposing the surface having the thermal barrier ceramic coating". Claims 1, 2, 4-9, 11-13, 15-19, 21-23, 25-27, 29, 32, 35 and 37-39 have been amended to correct any deficiencies related to this rejection, as such the rejection is moot and should be withdrawn.

II. Rejection of Claims 1, 2, 4-9, 11-13, 15-19, 21-23, 25-27, 29, 32, 35 and 37-39 Under 35 U.S.C. §112, second paragraph

Claims 1, 2, 4-9, 11-13, 15-19, 21-23, 25-27, 29, 32, 35 and 37-39 stand rejected under 35 U.S.C. §112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The Examiner states that there is insufficient antecedent basis for the limitation "the surface having the thermal barrier ceramic coating". Claims 1, 2, 4-9, 11-13, 15-19, 21-23, 25-27, 29, 32, 35 and 37-39 have been amended to correct any deficiencies related to this rejection, as such the rejection is moot and should be withdrawn.

III. <u>Rejection of Claims 1, 2, 4-9, 11-13, 15-19, 21-23, 25-27, 29, 32, 35 and 37-39 Under 35 U.S.C. §103(a)</u>

Claims 1, 2, 4-9, 11-13, 15-19, 21-23, 25-27, 29, 32, 35 and 37-39 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Farmer *et al.* (US 6,663,919) in view of Sangeeta *et al.* (US 5,976,265). It is respectfully requested that this rejection should be withdrawn for at least the following reasons. Farmer *et al.* and Sangeeta *et al.*, individually or in combination, do not teach or suggest each and every element as set forth in the subject claims.

The subject invention relates to a process which uses an air jet containing non-abrasive particulate media at a low pressure which selectively removes thermal barrier ceramic coatings from components without damaging the metallic substrate or the desired remaining thermal barrier ceramic coating system. Specifically, the method removes a thermal barrier ceramic coating from the cooling holes of a gas turbine engine component, such as a combustion chamber. Furthermore, independent claim 1 recites a process for removing a thermal barrier ceramic coating from a cooling hole of a component comprising: ***drilling cooling holes into the component after a bond coat application and prior to a thermal barrier ceramic coating application; directing an air jet at a side of the component, opposing a surface having the thermal barrier ceramic coating****, the jet containing a non-abrasive particulate media and emitting the media from a nozzle of the jet at a low pressure wherein said low pressure is insufficient for the media to damage a substrate but said low pressure is sufficient for the media to remove the thermal barrier ceramic coating from the cooling hole; and wherein a bond coating is interposed between the thermal barrier ceramic coating and the substrate; and* ***wherein the pressure of the air jet is from about 20 to 100 PSIG***. The cited references do not disclose or suggest such aspects of the claimed invention. Further, none of the cited references show the particular and specific process claimed.

Farmer *et al.* discloses coating a component surface containing cooling holes such that the coating deposits are introduced into the cooling holes. The component surface is coated with a metallic and/or ceramic coating material at a thickness that prevents the coating deposits from entirely filling the hole. The unfilled portion of the cooling holes provides a witness hole to guide the removal of the coating deposits. A high-pressure, liquid-containing jet is directed at the cooling holes from the surface of the component opposite the coated surface to remove the coating deposits in the cooling holes. Further, the high-pressure, liquid-containing jet contains a non-abrasive media in a carrier fluid to remove the coating material from the cooling holes. (*See*

col. 3, lines 26-44). However, those skilled in the art of advanced thermal barrier coating processing would realize that the non-abrasive media of Farmer *et al.*, in the carrier fluid plume (a water jet stream with a pressure of 6,000 to 15,000 psi with a high velocity/Mach speeds), would be instantly transformed into sharp abrasive particles by impacting the metallic substrate hole edges and metallic cooling hole interior under the high liquid jet pressure and high Mach speeds/velocity.

Farmer *et al.* does not disclose applying a bond coating to a substrate of a gas turbine engine component, manufacturing air cooling holes, and then applying a ceramic thermal barrier coating, as disclosed in applicants' amended claims. Specifically, applicants' claimed subject matter discloses applying a metallic bond coating to a substrate and then manufacturing air cooling holes in the component. A ceramic coating is then applied, which partially blocks the air cooling holes. An air jet is directed to the metallic surface side (i.e., non-coated side) of the component opposing the thermal barrier ceramic coated surface and directed at the air cooling holes to remove the ceramic thermal barrier deposits. (*See* Applicants' specification, pp. 10-11). As such, the air jet merely removes the ceramic thermal barrier deposits within the cooling holes and does not disturb or damage the air cooling holes, bond coat, metallic substrate or the remaining desired thermal barrier ceramic coating. In contrast, Farmer *et al.* manufactures cooling holes in a component and then coats the component surface with a metallic and/or ceramic coating material and a bond coat. Thus, the cooling holes of Farmer *et al.* are manufactured *before* any of the coating material is applied, causing the cooling holes to become deposited with all of the coating material. Whereas, applicants' claimed subject matter manufactures cooling holes *after* application of the substrate and bond coat but *before* the thermal barrier ceramic coating is applied, causing the cooling holes to become deposited with only the thermal barrier ceramic coating. (*See* pg. 1, paragraphs [0014]-[0016]).

Furthermore, Farmer *et al.* discloses the use of a very high pressure fluid system. Bond coat is applied and then removed from the cooling holes using a high pressure fluid system. Thermal barrier coating is then applied and removed from the cooling holes using the same high pressure fluid system. Typically, the process employs water pressurized to as much as 16,000 psi, preferably 6,000 psi up to about 15,000 psi. (*See* col. 5, lines 65-67). In contrast, applicant's claimed subject matter discloses a very low pressure dry system, wherein the pressure of the air jet is from about 20 to 100 psig. The system of Farmer *et al.* would cause unacceptable damage to the thermal barrier coating system as well as damage to the

component's small diameter cooling holes which would adversely affect gas turbine engine performance, operability and durability. Accordingly, Farmer *et al.* could not be used for manufacturing or repairing a jet engine component with cooling holes, bond coat and thermal barrier coating due to the fact that the very high fluid pressures required adversely affect the cooling hole required geometrical, dimensional and airflow characteristics. Specifically, the high pressure water jet process adversely affects component cooling hole/passage geometry (increases air flow, changes cooling hole shape and component cooling air discharge characteristics) which, in turn has a very negative effect on component cooling, gas turbine engine performance and component durability. Furthermore, it would be obvious to those skilled in the art of thermal barrier ceramic coatings that high pressure water jet blasting would also be detrimental to the bond coat and ceramic coating layer since the high velocity and/or high pressure would certainly result in ceramic coating layer delamination (due to the fact that the high pressure fluid at 6,000 to 15,000 psi in the cooling hole would easily lift the ceramic layer with a maximum bond strength of 1,500 psi from the metallic surfaces since the ceramic layer is already under compression and the water jet pressure greatly exceeds the bonding strength of the attached ceramic layer) and loss at the cooling hole exit area(s) or, at the minimum, create delamination initiation sites which would then experience coating loss during gas turbine engine operation. Accordingly, the "operativeness" of Farmer et al is very questionable. In contrast, applicants' claimed subject matter utilizes a low pressure air only process whereby all cooling hole/passage geometry and desired design characteristics are maintained or improved. Furthermore, thermal barrier ceramic coating integrity/durability is maintained and not compromised in any manner due to the low pressure process methodology.

Sangeeta *et al.* does not cure the deficiencies of Farmer *et al.* with respect to claim 1, Sangeeta *et al.* discloses a method of removing an aluminide-containing coating from the surface of a metal-based substrate. (*See* col. 2, lines 23-28). Specifically, the substrate is immersed in a bath of the stripping composition and agitated. The stripping composition degrades the surface of the coating. The degraded coating is then removed via an air stream without damaging the substrate (*See* col. 5, lines 5-60). The Examiner relies on Sangeeta *et al.* to disclose the use of an air jet in removing an aluminide-containing material from a metallic substrate surface. (*See* Non-Final Office Action dated 10-27-09, pg. 4). It is well known to those skilled in the art of advanced coatings that an aluminide coating is typically a metallic elemental aluminum coating which is applied (brush, spray or vapor deposition) and diffused (high temperature heat treatment) into the surface of a component while a thermal barrier

ceramic coating is a ceramic material heated to achieve a plasma state and then deposited on to the component surface in layers (typically via air plasma spraying). Accordingly, Sangeeta *et al.* does not disclose removing a thermal barrier ceramic coating. Applicants' claimed subject matter discloses a substrate and a bond coating that is applied to the gas turbine engine component. Air cooling holes are then manufactured in the component and a ceramic thermal barrier coating is applied, which partially blocks the air cooling holes. As stated *supra*, an air jet is directed to the non-coated side and directed at the air cooling holes to remove the ceramic thermal barrier deposits. In contrast, Sangeeta *et al.* discloses degrading and removing an aluminide-containing coating, not a thermal barrier ceramic coating. In fact, a thermal barrier ceramic coating is not even applied to the aluminide-containing coating of Sangeeta *et al.* The method of Sangeeta *et al.* is applied to removing only an aluminide-containing coating.

Furthermore, one of ordinary skill in the art would not be motivated to utilize the air jet of Sangeeta *et al.* on the thermal barrier ceramic coating of Farmer *et al.*, as Sangeeta *et al.* merely discloses a method of removing an aluminide-containing coating from the surface of the substrate via immersing the layers in a bath of stripping composition. One of ordinary skill in the art would understand the stripping composition to degrade a metallic coating and not a ceramic thermal barrier coating, as Sangeeta *et al.* makes no mention of degrading a thermal barrier ceramic coating or even applying a thermal barrier ceramic coating.

Furthermore, Farmer *et al.* teaches away from the use of Sangeeta *et al.*, as Farmer *et al.* discloses utilizing a high-pressure fluid system to remove a thermal barrier ceramic coating from cooling holes. Sangeeta *et al.* merely discloses utilizing an air jet to remove an aluminide-containing coating from the surface of a substrate. Thus, one of ordinary skill in the art would not be motivated to replace the high-pressure fluid system of Farmer *et al.* for removing a thermal barrier ceramic coating, with the low pressure air jet of Sangeeta *et al.* for removing an aluminide-coating. One of ordinary skill in the art wanting to apply Applicants' claimed process of removing ceramic thermal barrier deposits from cooling holes, would not look to Farmer *et al.* and Sangeeta *et al.* as the references disclose the utilization of a high-pressure fluid system for removing a thermal barrier ceramic coating and the use of a low pressure air jet for removing an aluminide-containing coating, respectively.

Furthermore, independent claim 8 recites a process for removing a thermal barrier ceramic coating selectively from a cooling hole of a metallic turbine engine component consisting essentially of: ***drilling cooling holes into the turbine component after a bond coat application and prior to a thermal barrier ceramic coating application; directing an***

***air jet at the cooling hole of the component, wherein the air jet is directed to a side, opposing a surface having the thermal barrier ceramic coating**, the jet containing non-abrasive particulate media and emitting the media from a nozzle of the jet at a low pressure wherein said low pressure is sufficient to selectively remove said thermal barrier ceramic coating yet insufficient for the media to damage an underlying metallic substrate of the cooling hole; and wherein a bond coating is interposed between the thermal barrier ceramic coating and the metallic substrate; and **wherein the pressure of the air jet is from about 20 to 100 PSIG**.* The cited references do not disclose or suggest such aspects of the claimed invention.

As stated *supra*, Farmer *et al.* discloses the use of a very high pressure fluid system. Bond coat is applied and then removed from the cooling holes using a high pressure fluid system. Thermal barrier coating is then applied and removed from the cooling holes using the same high pressure fluid system. In contrast, applicant's claimed subject matter discloses a very low pressure dry system, wherein the pressure of the air jet is from about 20 to 100 psig. The system of Farmer *et al.* would cause unacceptable damage to the thermal barrier coating system as well as damage to the component small diameter cooling holes which would adversely affect gas turbine engine performance, operability and durability. Farmer *et al.* could not be used for manufacturing or repairing a jet engine component with cooling holes, bond coat and thermal barrier coating due to the fact that the very high fluid pressures required adversely affect the cooling hole required dimensional and airflow characteristics as well as thermal barrier ceramic coating integrity and/or durability resulting in coating loss and failure.

Furthermore, Sangeeta *et al.* does not cure the deficiencies of Farmer *et al.* with respect to claim 8, Sangeeta *et al.* discloses degrading and removing an aluminide-containing coating, not a thermal barrier ceramic coating. Furthermore, Farmer *et al.* teaches away from the use of Sangeeta *et al.*, as Farmer *et al.* discloses utilizing a high-pressure fluid system to remove a thermal barrier ceramic coating from cooling holes. Sangeeta *et al.* merely discloses utilizing an air jet to remove an aluminide-containing coating from the surface of a substrate. Thus, one of ordinary skill in the art would not be motivated to replace the high-pressure fluid system of Farmer *et al.* for removing a thermal barrier ceramic coating, with the low pressure air jet of Sangeeta *et al.* for removing an aluminide-coating.

Further, independent claim 18 recites a process for forming cooling holes on a thermal barrier ceramic coated turbine engine component comprising: *drilling cooling holes into the component_after a bond coating application; coating the component containing the cooling holes*

with a thermal barrier ceramic coating; and ***directing an air jet at the cooling hole of the component, wherein the air jet is directed to a side, opposing a surface having the thermal barrier ceramic coating****, the jet containing non-abrasive particulate media and emitting the media from a nozzle of the jet at a low pressure wherein said low pressure is sufficient to selectively remove said thermal barrier ceramic coating yet insufficient for the media to damage an underlying metallic substrate of the cooling hole; and wherein the bond coating is interposed between the thermal barrier ceramic coating and the metallic substrate; and* ***wherein the pressure of the air jet is from about 20 to 100 PSIG****.*

As stated *supra*, Farmer *et al.* discloses the use of a very high pressure fluid system. In contrast, applicant's claimed subject matter discloses a very low pressure dry system. The system of Farmer *et al.* would cause unacceptable damage to the thermal barrier coating system as well as damage to the component small diameter cooling holes which would adversely affect gas turbine engine performance operability and durability. Farmer *et al.* could not be used for manufacturing or repairing a jet engine component with cooling holes, bond coat and thermal barrier coating due to the fact that the very high fluid pressures required adversely affect the cooling hole required dimensional and airflow characteristics as well as thermal barrier ceramic coating integrity and/or durability resulting in coating loss and failure.

Furthermore, Sangeeta *et al.* does not cure the deficiencies of Farmer *et al.* with respect to claim 18, Sangeeta *et al.* discloses degrading and removing an aluminide-containing coating, not a thermal barrier ceramic coating. Furthermore, Farmer *et al.* teaches away from the use of Sangeeta *et al.*, as Farmer *et al.* discloses utilizing a high-pressure fluid system to remove a thermal barrier ceramic coating from cooling holes. Sangeeta *et al.* merely discloses utilizing an air jet to remove an aluminide-containing coating from the surface of a substrate. Thus, one of ordinary skill in the art would not be motivated to replace the high-pressure fluid system of Farmer *et al.* for removing a thermal barrier ceramic coating with the low pressure air jet of Sangeeta *et al.* for removing an aluminide-coating.

In view of at least the above, it is readily apparent that the cited references fail to expressly or inherently disclose applicants' claimed subject matter as recited in claims 1, 2, 4-9, 11-13, 15-19, 21-23, 25-27, 29, 32, 35 and 37-39. Furthermore, the cited references lack the particular process content and cooperation between the elements which is specifically set forth in each of the present invention claims. In this case, the subject matter to be patented is sufficiently different from what has been referenced. The present invention process art

possesses the required novelty over the referenced art and provides for a process that is proven to be operative. The present invention art process is clearly defined providing a significant improvement and advancement in the field of advanced thermal barrier coating processing for gas turbine engines including flight quality engines that are required for commercial and military applications. Accordingly, it is respectfully requested that these claims be deemed allowable.

Conclusion

The present application is believed to be in condition for allowance in view of the above comments and amendments. A prompt action to such end is earnestly solicited.

In the event any fees are due in connection with this document, the Commissioner is authorized to charge those fees to Deposit Account No. 50-0983.

Should the Examiner believe a telephone interview would be helpful to expedite favorable prosecution, the Examiner is invited to contact applicants' undersigned representative at the telephone number below.

Buckingham, Doolittle & Burroughs, LLP
3800 Embassy Parkway
Suite 300
Akron, Ohio 44333
(330) 258-6405 (telephone)
(330) 258-6559 (fax)
Attorney Docket #: CGT-120 (58467.0028)

Respectfully Submitted,
Buckingham, Doolittle & Burroughs, LLP

/Marisa J. Zink/

Marisa J. Zink
MZink@bdblaw.com
Registration No.: 48,064

«AK3:1011887_v1»